DEPARTMENTS

Up Close With David Beverly and Curt Tallman

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EEE Links – What are the new materials/technologies that are using Space Station as a test-bed?

Tallman – Space Station is not really a test bed for new technologies, instead we try to use mature and proven parts for our core systems. All the basic computing systems, communication systems, data systems are using proven technology and we're not out on the edge of technology trying to innovate too much. This is particularly important when you have a 15 year program and must guarantee reliable operation given an ionizing radiation environment. As the number of experiments increases on Station then I am sure we will be using new technologies to capitalize on their advantage of expanded function, less power and much smaller size. I would hope we could work with the other centers to fly experiments that are using leading edge parts in an effort to see how well they perform against the reliability models for radiation and performance.

Beverly – Typically, we are not pushing technology in our manned space programs. In a rare case there is a hardware requirement that won't fit into the standard **SSQ 30312** EEE parts requirement plan and we start pushing the envelope a little bit, but we really haven't done that much because we want proven technology. One area where JSC is experimenting a little is the government furnished equipment (GFE) side of Station where we are using some commercial parts and off-the-shelf (OTS) hardware for low criticality applications. The challenge is to be able to accept OTS or commercial grade parts and come up with a reliable way of proving the hardware will work in low earth orbit.

Tallman – And we're not as power or space constrained as some of the satellites…things of that nature.

Beverly – We have pushed technology in a few areas, a good example would be on the DC to DC converter unit (DDCU). The initial part that was chosen happened to be from a qualified military manufacturer, but it began having reliability issues during field

testing. This device is handling a hundred amps and hundreds of volts. So given little time to fix the problem, the team went to an existing commercial part that was encapsulated in plastic. Boeing went to great lengths to insure the part would be reliable and thoroughly screened and qualified it for its tough environment. They're flying up there right now and so far we have had no problems. This approach went against the traditional wisdom by using a commercial part in a critical application.

Tallman – The DDCU box was basically a class B+ or class S minus level box. We ended up with a 100 Amp diode in there that has a die that was manufactured in Oregon, but the part was assembled in a plastic encapsulated case in the Philippines. We were able to buy them almost by the carload. The manufacturer had plenty of them and they were, as parts go, very inexpensive. We took a bunch of them and went through a very intensive qualification program and they worked very, very well. They passed our qualification program and now they've been in use and we are flying them in orbit. We've had no problems with them either in the box level testing and qualification or in orbit. So it shows that you can, with proper care, take some off the shelf parts and apply them in a low earth orbit application and apparently have a reliable product.

Beverly – At the same time, we cannot turn a sow's ear into a silk purse. We have to have a well-designed high quality part to begin with. All of the screening that was done, which was considerable, couldn't change what it basically was to begin with. Given the Station's 15 year plus mission, a poor quality part or an incorrectly selected part, will be nothing but trouble down the road.

EEE Links – How do you envision the role of advanced parts and packaging technologies and usage in Space Station evolution, over the next decade?

Beverly – We're seeing an evolution now as was mentioned earlier. The selection of leading edge or even several year old technology parts are hard to find on the qualified products list (QPL). We're moving more to commercial parts. Military parts are going to be rare and we're going to find high reliability commercial devices that will take their place. Technology is evolving so fast that it is not cost effective for a manufacturer to develop and qualify military grade parts with such limited sales potential. Since our options are decreasing I see us moving more and more to industrial grade parts as we redesign Space Station systems over its life. So as we do that, we are going to have to create a new set of requirements and test methods to allow us to use commercial parts in an extreme environment. Not only will the EEE parts engineer for Space Station need to change, we're all going to have to evolve if we are to continue to be successful in the space business.

Tallman – One of the things that I think you should note, is that for those electronic items that are maintained inside the pressurized environment of the Station the environment is not all that extreme. The temperature, humidity and pressure are all as it is, basically, here on earth. We don't have convection cooling, so we have to be a little more conserative in our power dissipation specifications. We still have some radiation

environment inside, even though there's quite a bit of shielding provided by the skin of the Station and also some of the internal systems have their own metal and outer shielding. The external hardware like the multiplexer/demultiplexers (MDMs) are actually mounted on the outside of the pressurized mating adapter, so they are subject to quite a bit of temperature fluctuation, as well as more of a hot belt radiation environment. In order to keep things from getting too cold, we do have heaters for external hardware. A lot of electronic parts will not operate correctly if we let them get much below minus 50 or 60 degrees centigrade. But, on the other hand, there seems to be a lot of parts available that can handle the environment out there. The big thing has been radiation, so we have to go to more radiation hardened and proven parts.

EEE Links – Which leads me to my next question. Has Space Station experienced any anomalies, failures, or memory/logic upset that can be attributed to Single Event Effects (SEE) in earth's radiation environment?

Beverly – If you look at the core hardware that we fly on Station, in the last year we have had some major solar flares that really might have shut down critical systems – but the primary Station functions performed flawlessly. I think that Boeing has done an excellent job in its design for radiation tolerance. Now if I look at some of the JSC provided and managed GFE we have had a few problems, but nothing that was not expected. We knew the risk for upset existed in some non-critical hardware and spares were flown to replace the hardware if problems did occur.

EEE Links - What role and impact do you think international participation will have in the development of Space Station activities in the future?

Beverly – I am concerned with the budget decreases that we are seeing. If the world could see how hard people are working here at JSC and around the program, hours and hours of uncompensated time, I think it becomes obvious that if we cut budgets any more than they've already been cut, I don't know how we're going to get our job done safely. So one of the alternatives is getting the world to buy into what we're doing. I think it builds their national pride and develops their space related engineering expertise, I am all for it.

EEE Links – How many people do you think are needed in order to do science?

Beverly – A minimum of six to seven people. I think that our partners have every right to have representatives on station and participate fully in as much science as can be achieved. The world needs to believe in the vision that Station brings. I think whoever got the international partners involved was visionary and I think it is the right thing to do. It also puts pressure back on the United States to keep funding Station because the rest of the world is depending on us to do our part. They're saying, "you better fund the CRV (Crew Rescue Vehicle) and a new Hab module". Without those additions, station is crew limited and our IPs will not be able to fully participate. We've been working with Government-Industry Data Exchange program (GIDEP) on the restrictions of passing

information to our international partners driven by the International Traffic in Arms Requirements (ITAR) requirements. In the past we have restricted the information that passes on to them on parts that they buy from American manufacturers and I think this is very unfortunate. We recently were notified that GIDEP would allow us now to share an abbreviated copy of the ALERTS with our partners. In the future they can get a sense of what our problems are and prevent those same problems in their hardware. Sure they're going to get access to some "American" technology, but they are building hardware for Station and if they fail, Station fails. I think there's going to have to be an evolution in mindset to understand that everyone is up there to win together.

EEE Links – How can the NASA Electronic Parts and Packaging Program (NEPP) and NASA EEE Parts Assurance Group (NEPAG) support those activities?

Beverly – As we move more away from military parts and into commercial and leading edge technology packaging, as well as die, NEPP needs to do what it's doing right now and continue to do advanced packaging studies and qualifications. What's cost effective…what technologies are reliable…what technologies work in our extreme environments. I think that they can serve an important part in helping Station continue to evolve by understanding what technologies are in fact faster, better, and cheaper. So I think NEPP can play an important part. One of their weaknesses in the past has been sharing their information with those of us out in the trenches. JPL can have the smartest engineers in the world but if they don't share what they know with the folks building the hardware, it has little value. I see this as a real challenge to NEPP - how to disseminate the most important information in the least amount of required reading time. Providing a web-page address or presenting a paper at a symposium is not good enough.

NEPAG, provides a EEE parts issues forum. Of course, it's a lot more than just the weekly telecons we have. It provides a forum to discuss problems we are having and inquire if anyone else has seen that problem. We are sharing real-time problems so we all become aware of them and can, hopefully, work together on solving and preventing their impact on our hardware. NEPAG has several important goals/deliverables that will be good tools when they are complete. One that comes to mind is to develop a NASA commercial parts selection and qualifications guideline. In other words; how should Parts Engineers around NASA approach and approve the use of commercial parts and/or off the shelf hardware? That's one of the tasks that NEPAG has that's not going to be easy. We'll have to look carefully at existing documents and decide if it might be better to borrow someone else's guidelines. The EEE parts community does not have enough resources to duplicate efforts from other organizations.